# A Virtual Research Model to Help Academics Face the Challenges of the 21st Century

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## Abstract

*The academic career and the stages of promotion of teachers and field researchers at the Egyptian universities as well as at many research centers available in Egypt's 26 provinces is guided by a set of rules and regulations that mainly depend on the number of publications that the researcher is producing in a specific period of time. It is also important to note that such publications should be published in well-known and accredited journals, transactions, and conference proceedings amongst others. These publications could be produced jointly with other institutions both locally and internationally. In all scenarios, one common problem always prevails, that is resources and funding. As for funding it is occasionally provided through international donors such as the European Union and the National Science Foundation. However, the problem remains in the local segment where various barriers are slowing down if not blocking the production of up-to-standard publications and research projects that are needed to contribute to the overall development of various sectors both quantitatively and qualitatively. Example barriers would include financial resources, required specialized equipment, as well as computing (hardware and software) and communication resources. In that respect, Scientific Computer Software Applications (SCSA) is becoming frequently the workhorse of research and development activities. Many software packages have been released to help researchers analyze and produce scientific publications. Most of these packages have a complicated design as well as expensive making it difficult to buy and not easy to understand by the user. Egypt, a developing country, lacks funding for research and development activities as compared to the United States and other European countries. The lack of financial resources and the scarcity of required resources make it difficult for academic researchers to build and excel in their academic careers. This paper demonstrates a new model namely; Virtual Research System (VRS), that is free from limitations of spatial distance and time and based mainly on information and communication technologies including the Internet to help leverage the quality and the quantity of academic researchers in Egyptian universities both locally as well as through collaborative work with other international research institutions. The paper provides an opportunity to share a wealth of information and knowledge that was never tapped before through the old accustomed to traditional techniques. The paper also demonstrates that new information and communication technologies are creating many challenges and opportunities for growth in different disciplines including research and development.*

Keywords: Research and Development, Virtual Organization, Information Technology, Scientific Research, Software Development.

## Overview

During the last decade, there has been a remarkable evolution in the areas of information, computing and communication reflecting clinical implications on changing the way people work, learn, govern, entertain, do business and communicate with each other (Alvarez, 1996). One of the most important turning points was the introduction and diffusion among societies of the fastest growing trend on planet earth "the Internet", which in no time became the main vehicle for communication contributing to globalisation and bringing people together irrespective of time and distance barriers (Bunderson, et al., 1987, Hoffman, et al., 1994, Suter, 1998 and 1999).

Today, information technology, based on merging computer and communication technologies, has become ubiquitous. Information technology has had an impact on virtually all sectors of the economy and all levels of the society, including academia and research (Threlkeld, et al., 1994). It has introduced and facilitated new methods of research and development, new forms of research collaboration, and new fields of science. Computers have affected research from its inception, and scientific users historically have had the most advanced computing capability.

Today, advances in the underlying technology make relatively advanced capabilities available more broadly, fueling

the diffusion of information technology from its historical stronghold in the physical sciences across the research community through other natural sciences, engineering, social sciences, and humanities. The complexity and breadth of a nation's science and engineering infrastructure is frequently described in terms of the financial resources it consumes and its personnel base. The output volume of research - *article count* - is one basic indicator of the degree to which different performers contribute to the world's production of research-based science and engineering knowledge (National Science Board, 2000a and 2000b).

The empirical relationship between the size of a nation's economy - its gross domestic product (GDP) - and its article output volume is moderately high. Clearly, however, some countries produce output well in excess of what would be expected, based on raw economic size. The world's key scientific and technical journals exercise a degree of quality control by requiring articles submitted for publication to undergo peer review. Thus, the volume of different countries' articles in these peer-reviewed journals is a rough indicator of their level of participation in the international science and engineering arena (National Science Board, 2000a).

The amount of information on the World Wide Web is approaching the amount of text in the largest libraries. The World Wide Web was estimated to contain 6 trillion bytes of text in February 1999 that is an equivalent to 6 million books (National Science Board, 2000a, 2000b). Moreover, about 6 percent of Web servers are based at universities, colleges, or research laboratories that take different form including the following:

A) Digital Libraries are becoming a reality and are separated by great spatial distances that could be linked electronically and accessed from other distant locations.

B) High-end Computing and Software has had a fundamental impact on research in many areas of science and technology. Some areas of research such as high-energy physics, fluid dynamics, aeronautical engineering and atmospheric sciences have long relied on high-end computing. The ability to collect, manipulate, and share massive amounts of data has long been essential in areas such as astronomy and geo-sphere and biosphere studies. As information technologies have became increasingly powerful, they have facilitated continued advances in these areas of science and become increasingly vital to sciences such as biology that historically used information technology less extensively. In addition to that specialized software packages like MATLAB, IDL, Mathematica, MINTAB, and SPSS can help the researchers to analyze and inference the scientific data and information (Heartsch et al., 1998).

C) Shared Databases have become important resources in many fields of science and social sciences. Examples include Census Bureau databases, data from large scientific instruments such as the Hubble Space Telescope, genetic and protein databases (e.g., GenBank), and the NIH-funded human brain project, as well as many smaller and more specialized databases. These databases allow researchers working on different pieces of large problems to contribute to and benefit from the work of other researchers and shared resources (Coleman, et al., 1999).

D) Modeling and Simulation Applications have become powerful complements to theory and experimentation in advancing knowledge in many areas of science. Simulations allow researchers to run virtual experiments that, for either physical or practical reasons, they cannot run in reality. As computer power grows, simulations can be made more complex, and new classes of problems can be realistically simulated. Simulation is contributing to major advances in weather and climate prediction, computational biology, plasma science, high-energy physics, cosmology, materials research, and combustion, Business and Management among other areas (Zaluzec, 1997).

## Problem Definition

Different factors are playing the driving forces to lead to the development of the proposed system (VRS). Lack of financial resources, lack of up-to-date and modernized laboratories as well as the cost of distance as a barrier are the main key elements that called for developing the new system and other similar functions and targets. Although the enormous efforts and the partially financial support of the governments of developing countries to research and development, is still below the amount that guarantees producing the high quality and required quantity of research compared to what is happening in the United States and European countries

This had put the researchers, especially who are working at the state-owned universities and research centers, in a serious and a relatively weak position. Despite these problems that are threatening researchers, they are still asked to produce a minimal amount of publications to develop their academic career and get promoted. For that reason, some of the academic staff has to finance their research projects on their own, although their salaries can not afford that load, which forces them to look for extra-work in other fields, just to leverage their income. However, it is only obvious that the research projects that come out fall under

basic research category with a sole objective to increase the article-count for the academic staff irrespective of the quality of the research projects, which exposes the work to be rejected by well-known journals and well-renowned international conferences. Respectively, the only venue becomes to publish in local conferences that usually lack international interactions and participation and hence accreditation as well as recognition.

Respectively, the research question that the current work is trying to answer is how to increase the article-count as well as its quality for academics so that they can pursue their academic career with a reasonable cost on the individual as well as on the research institutions. The issue is how to solve the problem of cost, problem of lack of modernized equipment and the expenses of specialized research-oriented software applications as well as that of international collaborative work including traveling and accommodation expenses amongst others.

## Objective

The short-term objective of the proposed system is to help produce basic academic researches. However the long-term objective is to help produce applied research and support its development processes. Thus, the goal of this paper is to shed the light on the conceptual framework for a web-based system (Klueber et al., 1999), namely the Virtual Research Systems (VRS), that help use today's most growing technology, the "Internet" in order to facilitate the remote usage of software applications for people who are working in the research and development environment.

The system encourages collaborative work by eliminating the distance and time factor. Digital libraries, and research-oriented software applications including simulation applications, as well as large database comprise the cornerstones of the proposed Virtual Research System (VRS).

## Proposed System (VRS)

The system is relying mainly on the World Wide Web technologies and on the application services provider trend (ASP) as an option to rent the very expensive software applications rather than to buy them. Following is a brief description of the VRS system. It is a website that enables the user (researcher) to have an access to data, information and scientific software applications as well as utilities, which are unavailable for public users giving him/her the ability to execute his/her tasks without the need for previous background about the applications (time saving).

The system does not only rent the software, but also provides a complete technical support to the users of these packages. The user probably does not know what application to use, and if he does, he might be unaware of how to use it (that's a very common case). In that case all he/she has to do is to give to the proposed system the data and to specify, what kind of processes it needs and guided by rule-based set of questions until he/she gets the proper informative description of the underling research problem.

The system can be accessed by anyone and the subscription is free of charge. However the users of the system are being charged according to the operations requested. VRS is sponsored by different parties mainly by software vendors that are producing the research-oriented applications and by the copyright of the shared databases as well as other components.

VRS includes mainly the following major modules:

- Digital libraries as a source of secondary data and information for the researchers
- Research-oriented software applications (for processing and analysis)
- Large database to provide the researchers with the important and necessary secondary data
- Simulated virtual instrumentation (virtual laboratories) for collecting primary data

The VRS also includes the following supportive modules:

- Electronic mail, electronic news and chat rooms to keep users informed about the latest data and feature updates as well as new features under development as well as to exchange information and experiences
- Results of some previously done researches
- Up-to-date statistical reports about researches
- Internet-based desktop video conferencing to support the collaborative work between researchers, that can involve many users from different sites
- Shared virtual workspaces, such as "white boards" on which researchers can sketch out ideas

The system is an integrative system designed on multilevel modules depending on the level of the user with his ability to use its different components. In the preliminary stages a brief description of the system and how to use it is offered to researchers. Moreover the system can provide a demo presentation of the capabilities of different software applications so that users can start developing their analysis (sort of Tutorial). As mentioned above the system will guide, in this stage, the users by different type of rule-based questions to help reach the proper and suitable analysis module for the research point under question.

Then the data are fed to the system for processing. The user will be introduced to how to upload their data in different suitable format from their side (the client side) to the group of servers, where all applications are available, via the Internet. This is followed by the processing of data in the requested form that will be sent back to the user to the client side. The system allows interactive sessions depending on the point being searched.

The system is also including simulated instruments (virtual laboratories) to help researchers perform their experiments from distance. In other words the researchers can use and control virtually the instruments remotely. These types of applications are very complicated and normally very expensive, but using the benefit of the applications service providers that the system provides can help reduce the cost of using them to the researchers.

It is also to notice that the system should not be installed on a single server, but on several servers that could be in one location or distributed in different locations

## Conclusion

Today's technology-driven societies must bridge the research gap between basic science and product development if it wants to remain on the cutting edge of the industry (National Science Board, 2000a, 2000b). This research is typically necessary to develop basic research results into an emerging technology and then into a marketable product. The proposed system is believed to introduce a qualitative and quantitative boom on research in Egypt due to its unique advantages of overcoming two of the most vital barriers that are information and financial resources. It also is perceived to encourage researchers from the industry and the business society to engage in research and development that could yield positive implications to their respective interests.

The decline of universities research laboratories as performers of basic research has increased the importance of university basic research to industry, indicating the need for effective collaborative work and VRS promises to revolutionize the way research is being planed, conducted and executed. With the use of information technology facilitates, more leveraged and enhanced collaboration among scientists and engineers will prevail. Moreover, electronic mail, the World Wide Web, and digital libraries will allow information to be accessed from anywhere and allow geographically distant scientists (even if they are only a building away) work together and better. Some companies with laboratories around the world pass off problems from one laboratory to another so researchers can work on the problems 24 hours a day (Zaluzec, 1997). However, the availability of information from anywhere may reduce the need for researchers to be close to major research libraries. The ability to operate major scientific instruments over the Web may reduce the need for scientists to be located at major laboratories. If virtual laboratories can function effectively, there may be less need to assemble large multidisciplinary teams of scientists and engineers at a laboratory to work on complex problems at a common location. Most scientists, however, may still want extensive face-to-face interaction with their colleagues, and they may want hands-on participation in experiments.

The proposed system (VRS) is a just step toward realizing the effective cooperative research work to increase the article count as well as to decrease the gap between the universities and industry.

The closing open question here is how can the advanced growing technologies help realizing that effective system in the future.

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## Biographies

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